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RELATIVE ABUNDANCE OF THREE VAEJOVID SCORPIONS ACROSS A HABITAT GRADIENT

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ABSTRACT

Relative abundance of three vaejovid scorpions was assessed using pitfall traps. Scorpions were sampled west of Albuquerque, Bernalillo Co., New Mexico during summer 1982. A total of 146 scorpions was captured in 3735 trap nights. *Paruroctonus utahensis* was the dominant species in flat grassland habitat (62-72% of captures). *Vaejovis coahuilae* and *V. russelli* were both found in the flat grassland habitat, but in lower numbers than *P. utahensis*. The two *Vaejovis* species were common in rocky cliff habitat (*V. coahuilae* 61%, *V. russelli* 37%) but *P. utahensis* was rare on the cliff (2% of captures). *Paruroctonus* may be unable to occupy the rocky cliff because it lacks suitable soil for burrowing.

INTRODUCTION

Three species of scorpions of the family Vaejovidae occur in the desert grasslands around Albuquerque, Bernalillo County, New Mexico. Two of the species are congeners, *Vaejovis coahuilae* Williams and *V. russelli* Williams: the third species is *Paruroctonus utahensis* (Williams). All three species are strictly nocturnal, and may be found on warm nights between March and November.

West of Albuquerque there is a gradual plain with sandy loam soil interrupted by a basalt cliff. The plain above the cliff slopes down to the east at about 2.6% to the cliff edge at an elevation of about 1616 m. The cliff drops about 30 m (25% slope) to a bajada (7-10% slope) then another gradual plain (3-5%). Above the cliff there exists a desert grassland composed primarily of mesa dropseed *(Sporobolus flexuosus)*, galleta *(Hilaria jamesii)*, black grama *(Bouteloua eriopoda)*, and rice grass *(Oryzopsis hymenoides)*. There are also widely scattered shrubs, primarily snakeweed *(Gutierrizia sarothrae)*, indigobush *(Dalea scoparia)*, four-winged saltbush *(Atriplex canescens)* and soapweed yucca *(Yucca glauca)*. The vegetation below is similar to that above the cliff, but is dominated by rice grass and indigobush. The vegetation on the cliff-face is a sparse community similar in composition to the surrounding plains.

Initial observations indicated that the two *Vaejovis* species were most common on the rocky slope, and less so above and below this area. *Paruroctonus*, however, was most often observed on the flat grassland habitat. During the summer of 1982 a trapping

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program was conducted to determine the relative abundances of these three species along this habitat gradient. Pitfall traps were used to capture scorpions. Unfortunately pitfall traps introduce several potential biases in sampling. First the more mobile species tend to be overrepresented in the pit samples. Secondly sampling was destructive, in that scorpions were removed from the area, potentially reducing population levels of the rare species. For this reason, additional data from nocturnal observations using a portable ultraviolet light have been included in the analysis.

METHODS

We buried 19 pitfall traps (470 ml plastic cups) flush with the soil surface along a transect running down the cliff-face. Ten were located between basalt boulders on the cliff-face, and the remainder were installed on the bajada below. An additional transect (19 pitfalls) was installed on the flats below the cliff. Traps were checked once every 2-3 days and all captured scorpions were removed and returned to the laboratory for identification. Scorpions captured in a pit grid 2 km N of this locality (above the cliffs) were also included in the analysis. The pit transects were sampled between 7 June and 8 August 1982. In addition to the pitfall capture data, we have included information on relative abundance obtained using a portable UV light. Black light samples were obtained between 25 May 1981 and 22 November 1982.

RESULTS

A total of 146 scorpions was captured in 3735 trap nights. *Paruroctonus utahensis* was the most common scorpion captured in the pits located on the flats above (72%) and below (61%) the cliff-face (Fig. 1). *Vaejovis coahuilae* outnumbered *V. russelli* in both flatland samples (Fig. 1). In contrast, *P. utahensis* constituted only 2% of the scorpions captured on the cliff-face (Fig. 1). *Vaejovis coahuilae* comprised 61% and *V. russelli* 37% of the cliff-face sample. The species proportions on the rocky slope are statistically different from those on the flats ($P < 0.001$, G-test; Sokal and Rohlf 1981). The differences between the two flatland samples are not statistically significant.

Information from black light surveys of these habitats confirm the pattern of segregation by habitat. Of 1837 scorpions located in the flatland habitat, 1646 or 90% were *Paruroctonus utahensis. Vaejovis coahuilae* comprised 7% of the sample (= 128 scorpions) and *Vaejovis russelli* made up only 3% of the total (63). The fact that this sample is more heavily biased toward *Paruroctonus* is undoubtedly due to the fact that blacklighting is not influenced by the differential mobility of the species. In limited blacklight sampling of the rocky slope habitat, only one individual of *Paruroctonus* was located, compared to 19 *V. coahuilae* and 11 *V. russelli.*

DISCUSSION

Clearly, *P. utahensis* exhibits a habitat occupancy pattern that is nearly the reverse of that of the *Vaejovis* species. Both *Vaejovis* species are found in burrows, under rocks, or under wood during the day. On the other hand, *P. utahensis* usually lives in a deep spiral burrow in the soil. The absence of *P. utahensis* on the cliff-face is possibly due to a lack of suitable burrow sites. There is evidence that some species of scorpions may be limited

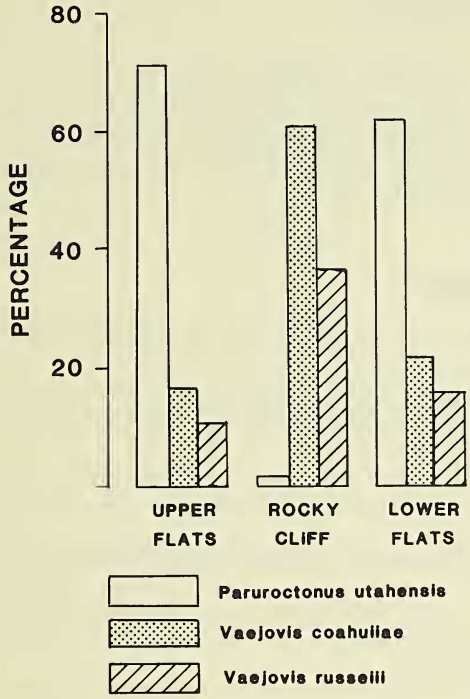

Fig. 1.–Proportions of the scorpion species captured in pitfall traps west of Albuquerque, New Mexico. The upper and lower flats samples were taken from relatively flat grassland habitat. The differences between these two flatland sites was not statistically significant. The rocky cliff sample was highly significantly different from the flatland samples ($P < 0.001$, G-Test).

by soil conditions for burrowing (Lamoral 1978). The soil present on the cliff face is often shallow (10-15 cm). *Paruroctonus* constructs burrows in the flatland habitat that are frequently deeper than 20 cm. Habitat segregation among scorpions into rock inhabiting forms and soil inhabiting forms has been reported before (Hadley and Williams 1968), Williams 1970, Koch 1978).

There are several possible explanations for the decreased numbers of *Vaejovis* on the flats. One is that cliffs represent better habitat for the two *Vaejovis* species studied here. A second is that both *Vaejovis* species are excluded from the flatland habitat by competition with *P. utahensis.* These three species may compete exploitatively. Williams (1970) indicated that the two main factors permitting coexistence between scorpions in the Phoenix South Mountain area were probably habitat specialization and differential prey preference. Whether differential habitat occupancy between the two *Vaejovis* species studied by Williams was the result of past competitive interactions is unknown. There is some overlap in prey eaten by the three sympatric scorpions (Bradley, pers. obs.). The answer to the question of exploitation competition must await quantitative analysis of the resource base that is presumed to be limiting.

We have observed interspecific predation among these three scorpion species. *Vaejovis russelli* eating a juvenile *Paruroctonus utahensis, P. utahensis* eating young *V. coahuilae* (2 occasions), and *V. coahuilae* eating a young *V. russelli.* All three species overlap widely in size, and small individuals are subject to cannibalism as well as predation by the other scorpion species. Interspecific predation may represent a potent form of interference competition among scorpions (Polis et al. 1981). Proof that interference competition influences the distribution of these three scorpions will require analysis of population regulation in these forms.

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LITERATURE CITED

Hadley, N. F. and S. C. Williams. 1968. Surface activities of some North American scorpions in relation to feeding. Ecology, 49:726-734.

Koch, L. E. 1978. A comparative study of the structure, function and adaptation to different habitats of burrows in the scorpion genus *Urodacus* (Scorpionida, Scorpionidae). Rec. Western Australian Mus., 6:119-146.

Lamoral, B. H. 1978. Soil hardness, an important and limiting factor in burrowing scorpions of the genus *Opisthophthalmus* C. L. Koch, 1837 (Scorpionidae, Scorpionida). Symp. Zool. Soc. London, 42:171-181.

Polis, G. A., W. D. Sissom, and S. J. McCormick. 1981. Predators of scorpions: field data and a review. J. Arid Environ., 4:309-326.

Sokal R. R. and F. J. Rohlf. 1981. Biometry (2nd ed.). W. H. Freeman and Co. San Francisco. 859 pp.

Williams, S. C. 1968. Methods of sampling scorpion populations. Proc. California Acad. Sci., 36:221-230.

Williams, S. C. 1970. Coexistence of desert scorpions by differential habitat preference. Pan-Pacific Entomol., 46:254-267.

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